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U S NAVAL PROVING GROUND
DAHLGREN VIRGINIA

REPORT NO 1149

TESTING OF WARHEADS FOR
AIR TARGET GUIDED MISSILES

65th Partial Report

FRAGMENTATION TEST OF WARHEAD
NO 145 FOR ORIOLE MISSILE

FINAL Report

Copy No 11

Task

Assignment SFG Re31 607 53

Classification CONFIDENTIAL

SECURITY INFORMATION

Fragmentation Test of Warhead No. 145 for Oriole Missile

PART A

SYNOPSIS

1. The testing of warheads 145-A, 145-B, 145-C, and 145-D was conducted to determine the effect of geometry of explosive loading on the fragment velocity and space distribution pattern of Oriole warheads having small length to diameter ratios. The warheads were cylinders 10" in outside diameter and 4" in length with various end plate designs.
2. a. Warheads 145-A, 145-B, 145-C and 145-D produced fragment velocities which increased as the weight of explosive was increased.

b. Warheads 145-A with flat end plates, warheads 145-B with conical end plates oriented to reduce the charge, and warheads 145-C with conical end plates oriented to increase the charge all had similar space distribution patterns.

c. Warhead 145-D, which had higher cones and more explosive than warhead 145-C, used a dual initiation. It showed a great increase in the number of fragments over warheads 145-A, 145-B, and 145-C and a wider beam spread. It would appear that the wider spread is a result of the dual initiation, but no definite conclusion can be reached since no warhead of similar geometry was tested with single initiation.

Fragmentation Test of Warhead No. 145 for Oriole Missile

TABLE OF CONTENTS

	<u>Page</u>
SYNOPSIS.	1
TABLE OF CONTENTS	2
AUTHORITY	3
REFERENCES.	3
BACKGROUND.	3
OBJECT OF TEST.	3
PERIOD OF TEST.	3
REPRESENTATIVES PRESENT	3
DESCRIPTION OF ITEMS UNDER TEST	4
PROCEDURE	5
RESULTS AND DISCUSSION.	6
CONCLUSIONS	7
APPENDIX A - WARHEAD NO. 145.	FIGURES 1-4 (Incl)
DETONATION TRAIN OF WARHEAD	
NO. 145-D.	FIGURE 5
APPENDIX B - TEST SET-UP.	FIGURE 6
APPENDIX C - FRAGMENT VELOCITY DATA	TABLES I-XI (Incl)
APPENDIX D - SPACE DISTRIBUTION DATA.	TABLE XII
APPENDIX E - DISTRIBUTION	1-2 (Incl)

Fragmentation Test of Warhead No. 145 for Oriole Missile
-----PART BINTRODUCTION

1. AUTHORITY:

This test was authorized by reference (a) and conducted under Task Assignment NPG-Re3f-607-1-53, reference (b).

2. REFERENCES:

- a. NOL Conf Work Request WC/40/53 of 10 March 1953
- b. BUORD Conf ltr NP9-Re3f-RKJ:gg Ser 42699 of 29 July 1952

3. BACKGROUND:

a. Reference (b) authorized the Naval Proving Ground to work directly with the Naval Ordnance Laboratory in the development and testing of warheads for guided missiles.

b. Reference (a) requested that 12 warheads No. 145, 3 of each modification 145-A, 145-B, 145-C and 145-D made of cylindrical cases, 10" in diameter and 4" long, and having four (4) styles of end plates be loaded with composition C-3 and tested for fragment velocity and space distribution.

4. OBJECT OF TEST:

The testing of warheads 145-A, 145-B, 145-C, and 145-D was intended to determine the effect of geometry of explosive loading on the fragment velocity and space distribution pattern of Oriole warheads having small length to diameter ratios.

5. PERIOD OF TEST:

- | | |
|-------------------------------------|---------------|
| a. Date of Project Letter | 10 March 1953 |
| b. Date Necessary Material Received | 17 March 1953 |
| c. Date Commenced Test | 15 April 1953 |
| d. Date Test Completed | 24 April 1953 |

6. REPRESENTATIVES PRESENT:

This test was witnessed in part by Messrs. L. E. Hightower, D. J. Stretmator and P. Popernack representing the Naval Ordnance Laboratory.

Fragmentation Test of Warhead No. 145 for Oriole Missile
-----PART CDETAILS OF TEST

7. DESCRIPTION OF ITEMS UNDER TEST:

a. The twelve (12) warheads No. 145 were cylinders of steel 10"O in outside diameter, 4"O long and 3/8" wall thickness. Three each of these were designated for the 4 types of end plates, A, B, C, and D.

b. Warheads 145-A, Figure 1, used flat end plates 1/16" thick. One end plate contained a hole 2" in diameter where a 1" tetryl booster was placed. Warheads 145-B and 145-C, Figures 2 and 3, had cone shaped end plates 1/16" thick, 1-1/2" high truncated by a 2" hole for the boosters. In warhead 145-B the cones were turned inward and in 145-C the cones were oriented outward. Warhead 145-D, Figure 4, was similar to warhead 145-C with the single exception that the cone-shaped end plates were 3" high.

c. Warheads 145-A, 145-B and 145-C were each initiated at the top (0°) with an engineers' special blasting cap and 1" x 1" tetryl booster, while warheads 145-D were each dually initiated at the top and bottom (0° and 180°) by an engineers' special blasting cap and two primacord leads to two 1" x 1" tetryl boosters. The detonation train for warheads 145-D is shown in Figure 5.

Fragmentation Test of Warhead No. 145 for Oriole Missile

d. The warhead and filler weights are as follows:

Oriole Warheads NOL 145-A-B-C-D

30' Velocity Arena

<u>Warhead No.</u>	<u>Empty wt.lbs.</u>	<u>Comp. C-3 wt.lbs.</u>	<u>Total wt.lbs.</u>	<u>Cone* heights</u>
145-A-1	15.74	15.54	31.28	0"
145-A-2	15.61	15.36	30.97	0"
145-A-3	15.38	15.49	31.07	0"
145-B-1	15.86	11.06	26.92	-1-1/2"
145-B-2	15.85	11.03	26.88	-1-1/2"
145-B-3	15.76	11.21	26.97	-1-1/2"
145-C-1	15.83	19.99	35.82	+1-1/2"
145-C-2	15.69	19.86	35.55	+1-1/2"
145-C-3	15.85	19.88	35.73	+1-1/2"
145-D-1	16.23	24.97	41.20	+3"
145-D-2	16.29	24.99	41.28	+3"
145-D-3	16.17	25.06	41.23	+3"

* See Figures 1, 2, 3, and 4.

8. PROCEDURE:

Each warhead was placed with its axis vertical at the center of a 30' radius arena on a 7-1/2' high platform. Fragment velocities were obtained by recording hits with a 16mm Fastax camera. The 30 ft. radius velocity arena consisted of steel plates 1" thick in longitudinal zones 350° to 50°, called "L", and 123° to 123°, called "R" in Table XII. Space distribution was determined by dividing these plates into polar zones of 5° each from 75° to 100°. In these zones all hits were recorded if they were estimated to be able to penetrate 1/8" mild steel plate. The recorded hits represent 1/3 of the number expected for the total polar zones.

Fragmentation Test of Warhead No. 145 for Oriole Missile

9. RESULTS AND DISCUSSION:

a. The velocity results, detailed in Tables I through XI, are summarized as follows:

<u>Warheads</u>	<u>Cone heights</u>	<u>Average Charge (lbs.)</u>	<u>Average Velocity</u>
145-A	0"	15.5	4460 ft./sec.
145-B	-1-1/2"	11.1	4220 ft./sec.
145-C	+1-1/2"	19.9	4770 ft./sec.
145-D	+3"	25.0	5590 ft./sec.

b. The space distribution data detailed in Table XII are summarized in the following table.

<u>Polar Zone</u>	<u>3 round Average of No. of hits on Arena</u>			
	<u>145-A*</u>	<u>145-B</u>	<u>145-C</u>	<u>145-D</u>
75°-80°	7	5	4	14
80°-85°	8	5	15	43
85°-90°	36	48	18	70
90°-95°	75	74	68	71
95°-100°	<u>8</u>	<u>5</u>	<u>7</u>	<u>30</u>
Total	134	137	112	228
% in Zone				
85°-95°	82.5	88.6	78.7	61.7

* 2 round average, No. 145-A-1 did not detonate.

It appears that by dually initiating warhead No. 145-D, a wider beam of fragments resulted.

Fragmentation Test of Warhead No. 145 for Oriole Missile

PART D

CONCLUSIONS

10. a. Warheads 145-A, 145-B, 145-C, and 145-D produced velocities which increased as the weight of the explosive was increased.

b. Warheads 145-A, 145-B, and 145-C had relatively similar space distribution patterns.

c. Warhead 145-D, which had a dual initiation showed a great increase in the number of fragments than warheads 145-A, 145-B and 145-C and had a wider beam spread. It would appear that the wider spread is a result of the dual initiation, but no definite conclusion can be reached since no warhead of similar geometry was tested with single initiation.

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NPG REPORT NO. 1149

Fragmentation Test of Warhead No. 145 for Oriole Missile

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DAHLGREN, VIRGINIA

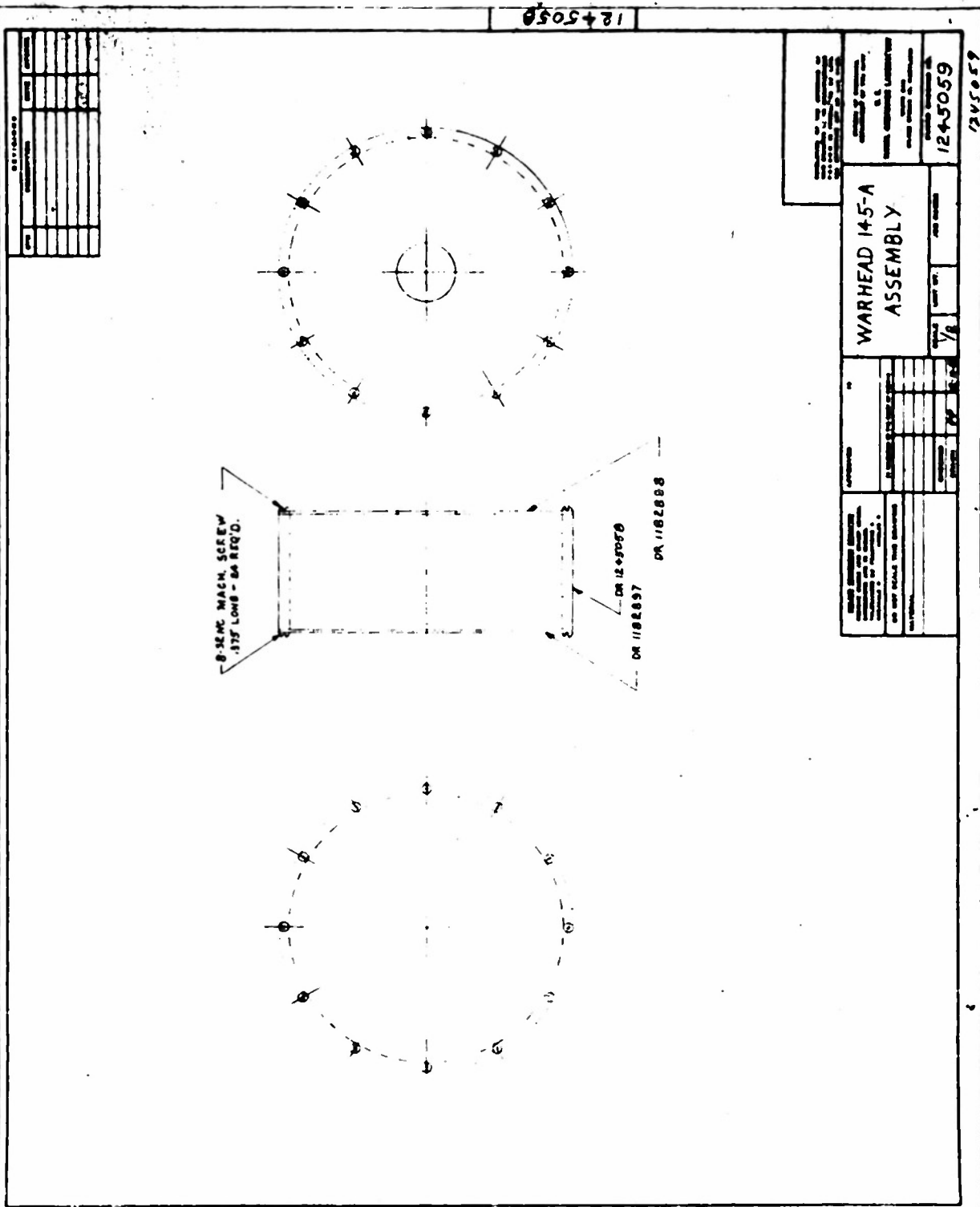
Sixty-fifth Partial Report
on
Testing of Warheads for
Air Target Guided Missiles

Final Report
on
Fragmentation Test of Warhead
No. 145 for Oriole Missile

Project No.: NPG-Re3f-607-1-53
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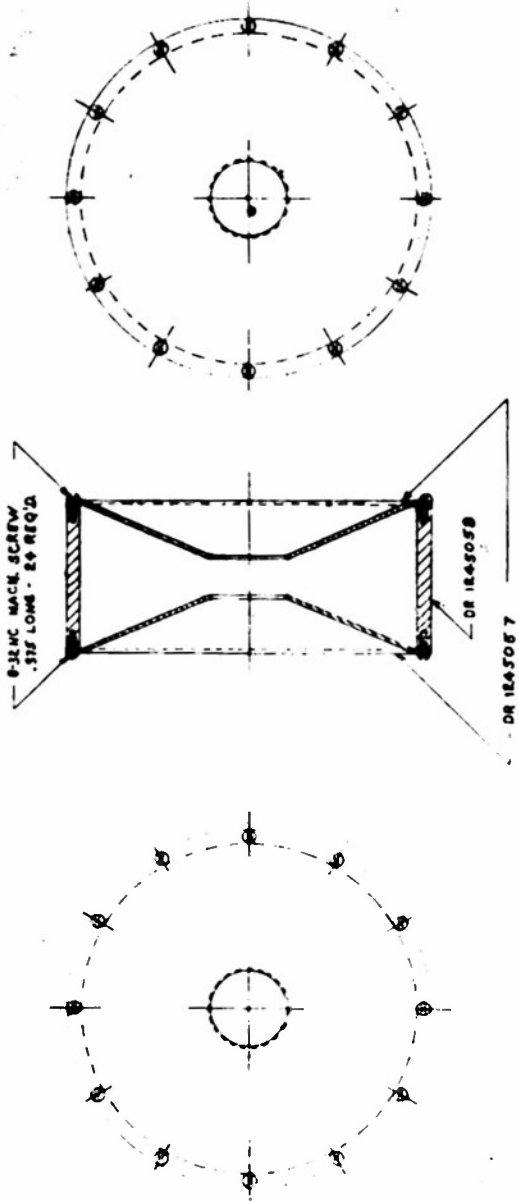
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12	REVISION	12/1/59	J. L. H.

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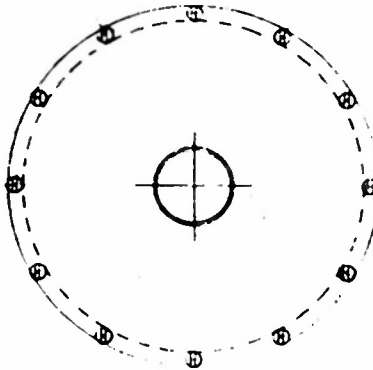
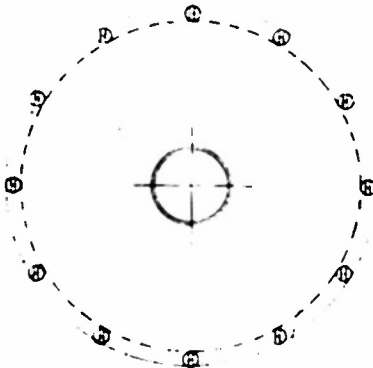
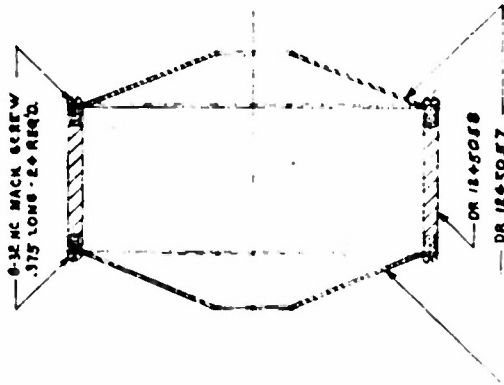
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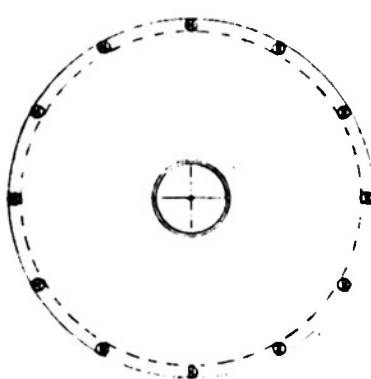
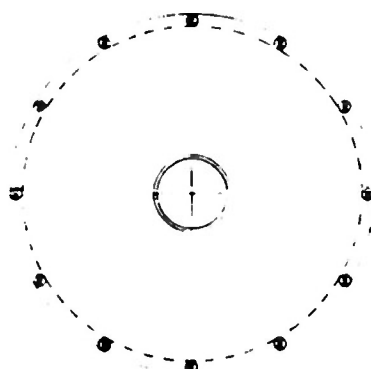
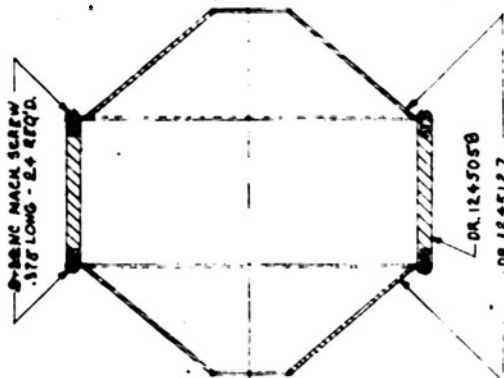
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RISK ASSESSMENT OF THE PROJECT 40. CONCLUSION OF THE PROJECT		41. NAME OF THE PROJECT 42. SUMMARY OF THE PROJECT 43. OBJECTIVES OF THE PROJECT 44. SCOPE OF THE PROJECT 45. BUDGET OF THE PROJECT 46. TIMELINE OF THE PROJECT 47. RISK ASSESSMENT OF THE PROJECT 48. CONCLUSION OF THE PROJECT		49. NAME OF THE PROJECT 50. SUMMARY OF THE PROJECT 51. OBJECTIVES OF THE PROJECT 52. SCOPE OF THE PROJECT 53. BUDGET OF THE PROJECT 54. TIMELINE OF THE PROJECT 55. RISK ASSESSMENT OF THE PROJECT 56. CONCLUSION OF THE PROJECT		57. NAME OF THE PROJECT 58. SUMMARY OF THE PROJECT 59. OBJECTIVES OF THE PROJECT 60. SCOPE OF THE PROJECT 61. BUDGET OF THE PROJECT 62. TIMELINE OF THE PROJECT 63. RISK ASSESSMENT OF THE PROJECT 64. CONCLUSION OF THE PROJECT		65. NAME OF THE PROJECT 66. SUMMARY OF THE PROJECT 67. OBJECTIVES OF THE PROJECT 68. SCOPE OF THE PROJECT 69. BUDGET OF THE PROJECT 70. TIMELINE OF THE PROJECT 71. RISK ASSESSMENT OF THE PROJECT 72. CONCLUSION OF THE PROJECT		73. NAME OF THE PROJECT 74. SUMMARY OF THE PROJECT 75. OBJECTIVES OF THE PROJECT 76. SCOPE OF THE PROJECT 77. BUDGET OF THE PROJECT 78. TIMELINE OF THE PROJECT 79. RISK ASSESSMENT OF THE PROJECT 80. CONCLUSION OF THE PROJECT		81. NAME OF THE PROJECT 82. SUMMARY OF THE PROJECT 83. OBJECTIVES OF THE PROJECT 84. SCOPE OF THE PROJECT 85. BUDGET OF THE PROJECT 86. TIMELINE OF THE PROJECT 87. RISK ASSESSMENT OF THE PROJECT 88. CONCLUSION OF THE PROJECT		89. NAME OF THE PROJECT 90. SUMMARY OF THE PROJECT 91. OBJECTIVES OF THE PROJECT 92. SCOPE OF THE PROJECT 93. BUDGET OF THE PROJECT 94. TIMELINE OF THE PROJECT 95. RISK ASSESSMENT OF THE PROJECT 96. CONCLUSION OF THE PROJECT		97. NAME OF THE PROJECT 98. SUMMARY OF THE PROJECT 99. OBJECTIVES OF THE PROJECT 100. SCOPE OF THE PROJECT 101. BUDGET OF THE PROJECT 102. TIMELINE OF THE PROJECT 103. RISK ASSESSMENT OF THE PROJECT 104. CONCLUSION OF THE PROJECT		105. NAME OF THE PROJECT 106. SUMMARY OF THE PROJECT 107. OBJECTIVES OF THE PROJECT 108. SCOPE OF THE PROJECT 109. BUDGET OF THE PROJECT 110. TIMELINE OF THE PROJECT 111. RISK ASSESSMENT OF THE PROJECT 112. CONCLUSION OF THE PROJECT		113. NAME OF THE PROJECT 114. SUMMARY OF THE PROJECT 115. OBJECTIVES OF THE PROJECT 116. SCOPE OF THE PROJECT 117. BUDGET OF THE PROJECT 118. TIMELINE OF THE PROJECT 119. RISK ASSESSMENT OF THE PROJECT 120. CONCLUSION OF THE PROJECT		121. NAME OF THE PROJECT 122. SUMMARY OF THE PROJECT 123. OBJECTIVES OF THE PROJECT 124. SCOPE OF THE PROJECT 125. BUDGET OF THE PROJECT 126. TIMELINE OF THE PROJECT 127. RISK ASSESSMENT OF THE PROJECT 128. CONCLUSION OF THE PROJECT		129. NAME OF THE PROJECT 130. SUMMARY OF THE PROJECT 131. OBJECTIVES OF THE PROJECT 132. SCOPE OF THE PROJECT 133. BUDGET OF THE PROJECT 134. TIMELINE OF THE PROJECT 135. RISK ASSESSMENT OF THE PROJECT 136. CONCLUSION OF THE PROJECT		137. NAME OF THE PROJECT 138. SUMMARY OF THE PROJECT 139. OBJECTIVES OF THE PROJECT 140. SCOPE OF THE PROJECT 141. BUDGET OF THE PROJECT 142. TIMELINE OF THE PROJECT 143. RISK ASSESSMENT OF THE PROJECT 144. CONCLUSION OF THE PROJECT		145. NAME OF THE PROJECT 146. SUMMARY OF THE PROJECT 147. OBJECTIVES OF THE PROJECT 148. SCOPE OF THE PROJECT 149. BUDGET OF THE PROJECT 150. TIMELINE OF THE PROJECT 151. RISK ASSESSMENT OF THE PROJECT 152. CONCLUSION OF THE PROJECT		153. NAME OF THE PROJECT 154. SUMMARY OF THE PROJECT 155. OBJECTIVES OF THE PROJECT 156. SCOPE OF THE PROJECT 157. BUDGET OF THE PROJECT 158. TIMELINE OF THE PROJECT 159. RISK ASSESSMENT OF THE PROJECT 160. CONCLUSION OF THE PROJECT		161. NAME OF THE PROJECT 162. SUMMARY OF THE PROJECT 163. OBJECTIVES OF THE PROJECT 164. SCOPE OF THE PROJECT 165. BUDGET OF THE PROJECT 166. TIMELINE OF THE PROJECT 167. RISK ASSESSMENT OF THE PROJECT 168. CONCLUSION OF THE PROJECT		169. NAME OF THE PROJECT 170. SUMMARY OF THE PROJECT 171. OBJECTIVES OF THE PROJECT 172. SCOPE OF THE PROJECT 173. BUDGET OF THE PROJECT 174. TIMELINE OF THE PROJECT 175. RISK ASSESSMENT OF THE PROJECT 176. CONCLUSION OF THE PROJECT		177. NAME OF THE PROJECT 178. SUMMARY OF THE PROJECT 179. OBJECTIVES OF THE PROJECT 180. SCOPE OF THE PROJECT 181. BUDGET OF THE PROJECT 182. TIMELINE OF THE PROJECT 183. RISK ASSESSMENT OF THE PROJECT 184. CONCLUSION OF THE PROJECT		185. NAME OF THE PROJECT 186. SUMMARY OF THE PROJECT 187. OBJECTIVES OF THE PROJECT 188. SCOPE OF THE PROJECT 189. BUDGET OF THE PROJECT 190. TIMELINE OF THE PROJECT 191. RISK ASSESSMENT OF THE PROJECT 192. CONCLUSION OF THE PROJECT		193. NAME OF THE PROJECT 194. SUMMARY OF THE PROJECT 195. OBJECTIVES OF THE PROJECT 196. SCOPE OF THE PROJECT 197. BUDGET OF THE PROJECT 198. TIMELINE OF THE PROJECT 199. RISK ASSESSMENT OF THE PROJECT 200. CONCLUSION OF THE PROJECT		201. NAME OF THE PROJECT 202. SUMMARY OF THE PROJECT 203. OBJECTIVES OF THE PROJECT 204. SCOPE OF THE PROJECT 205. BUDGET OF THE PROJECT 206. TIMELINE OF THE PROJECT 207. RISK ASSESSMENT OF THE PROJECT 208. CONCLUSION OF THE PROJECT		209. NAME OF THE PROJECT 210. SUMMARY OF THE PROJECT 211. OBJECTIVES OF THE PROJECT 212. SCOPE OF THE PROJECT 213. BUDGET OF THE PROJECT 214. TIMELINE OF THE PROJECT 215. RISK ASSESSMENT OF THE PROJECT 216. CONCLUSION OF THE PROJECT		217. NAME OF THE PROJECT 218. SUMMARY OF THE PROJECT 219. OBJECTIVES OF THE PROJECT 220. SCOPE OF THE PROJECT 221. BUDGET OF THE PROJECT 222. TIMELINE OF THE PROJECT 223. RISK ASSESSMENT OF THE PROJECT 224. CONCLUSION OF THE PROJECT		225. NAME OF THE PROJECT 226. SUMMARY OF THE PROJECT 227. OBJECTIVES OF THE PROJECT 228. SCOPE OF THE PROJECT 229. BUDGET OF THE PROJECT 230. TIMELINE OF THE PROJECT 231. RISK ASSESSMENT OF THE PROJECT 232. CONCLUSION OF THE PROJECT		233. NAME OF THE PROJECT 234. SUMMARY OF THE PROJECT 235. OBJECTIVES OF THE PROJECT 236. SCOPE OF THE PROJECT 237. BUDGET OF THE PROJECT 238. TIMELINE OF THE PROJECT 239. RISK ASSESSMENT OF THE PROJECT 240. CONCLUSION OF THE PROJECT		241. NAME OF THE PROJECT 242. SUMMARY OF THE PROJECT 243. OBJECTIVES OF THE PROJECT 244. SCOPE OF THE PROJECT 245. BUDGET OF THE PROJECT 246. TIMELINE OF THE PROJECT 247. RISK ASSESSMENT OF THE PROJECT 248. CONCLUSION OF THE PROJECT		249. NAME OF THE PROJECT 250. SUMMARY OF THE PROJECT 251. OBJECTIVES OF THE PROJECT 252. SCOPE OF THE PROJECT 253. BUDGET OF THE PROJECT 254. TIMELINE OF THE PROJECT 255. RISK ASSESSMENT OF THE PROJECT 256. CONCLUSION OF THE PROJECT		257. NAME OF THE PROJECT 258. SUMMARY OF THE PROJECT 259. OBJECTIVES OF THE PROJECT 260. SCOPE OF THE PROJECT 261. BUDGET OF THE PROJECT 262. TIMELINE OF THE PROJECT 263. RISK ASSESSMENT OF THE PROJECT 264. CONCLUSION OF THE PROJECT		265. NAME OF THE PROJECT 266. SUMMARY OF THE PROJECT 267. OBJECTIVES OF THE PROJECT 268. SCOPE OF THE PROJECT 269. BUDGET OF THE PROJECT 270. TIMELINE OF THE PROJECT 271. RISK	
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15 April 1953
30 ft. Arena with Warhead 1454D in place.
Figure 6

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SECURITY INFORMATION

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Fragmentation Test of Warhead No. 145 for Oriole Missile
-----TABLE IFRAGMENT VELOCITY DATA

30' Radius Velocity Arena 5850 Frames per sec.
16mm Fastax Camera Comp. C-3
Rd. 2, Oriole Warhead No. 145-A-2 Filler Weight 15.36 lbs.
Total Weight 30.97 lbs. Date: 15 April 1953

<u>Frame in Which Hit Occurred</u>	<u>No. Fragments</u>	<u>Velocity (f/s)</u>
35	8	5010
36	7	4880
37	7	4740
38	4	4620
39	1	4500
41	2	4280
42	6	4180
43	5	4080
44	4	3990
45	5	3900
46	2	3820
47	2	3730
Median		4520
Average		4430

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NPG REPORT NO. 1149

Fragmentation Test of Warhead No. 145 for Oriole Missile

TABLE II

FRAGMENT VELOCITY DATA

30' Radius Velocity Arena 4650 Frames per sec.
16mm Fastax Camera Comp. C-3
Rd. 3, Oriole Warhead No. 145-A-3 Filler Weight 15.49 lbs.
Total Weight 31.07 lbs. Date: 15 April 1953

<u>Frame in Which Hit Occurred</u>	<u>No. Fragments</u>	<u>Velocity (f/s)</u>
27	2	5170
28	19	4980
29	4	4810
30	6	4650
31	3	4500
32	1	4360
33	5	4230
34	7	4100
35	5	3990
36	3	3880
37	1	3770
38	1	3670
39	2	3580
40	1	3490
Median		4630
Average		4490

CONFIDENTIAL
SECURITY INFORMATION

APPENDIX C

CONFIDENTIAL

NPG REPORT NO. 1149

Fragmentation Test of Warhead No. 145 for Oriole Missile

TABLE III

FRAGMENT VELOCITY DATA

30' Radius Velocity Arena 5850 Frames per sec.
16mm Fastax Camera Comp. C-3
Rd. 10, Oriole Warhead No. 145-B-1 Filler Weight 11.06 lbs.
Total Weight 26.92 lbs. Date: 17 April 1953

<u>Frame in Which Hit Occurred</u>	<u>No. Fragments</u>	<u>Velocity (f/s)</u>
38	4	4620
39	6	4500
40	4	4390
41	5	4280
42	8	4180
43	5	4080
44	3	3990
45	1	3900
47	1	3730
50	1	3510
51	2	3440
Median		4290
Average		4210

CONFIDENTIAL
SECURITY INFORMATION

APPENDIX C

CONFIDENTIAL

NPG REPORT NO. 1149

Fragmentation Test of Warhead No. 145 for Oriole Missile

TABLE IV

FRAGMENT VELOCITY DATA

30' Radius Velocity Arena	5800 Frames per sec.
16mm Fastax Camera	Comp. C-3
Rd. 11, Oriole Warhead No. 145-B-2	Filler Weight 11.03 lbs.
Total Weight 26.88 lbs.	Date: 17 April 1953

<u>Frame in Which Hit Occurred</u>	<u>No. Fragments</u>	<u>Velocity (f/s)</u>
38	4	4580
39	10	4460
40	11	4350
41	9	4240
42	5	4140
43	4	4050
47	1	3700
49	1	3550
52	1	3350
Median		4360
Average		4270

CONFIDENTIAL
SECURITY INFORMATION

APPENDIX C

CONFIDENTIAL

NPG REPORT NO. 1149

Fragmentation Test of Warhead No. 145 for Oriole Missile

TABLE V

FRAGMENT VELOCITY DATA

30' Radius Velocity Arena 5700 Frames per sec.
16mm Fastax Camera Comp. C-3
Rd. 12, Oriole Warhead No. 145-B-3 Filler Weight 11.21 lbs.
Total Weight 26.97 lbs. Date: 17 April 1953

<u>Frame in Which Hit Occurred</u>	<u>No. Fragments</u>	<u>Velocity (f/s)</u>
37	2	4620
38	9	4500
39	5	4380
40	5	4280
41	4	4170
42	5	4070
43	2	3980
44	2	3890
45	1	3800
46	1	3720
48	1	3560
50	1	3420
51	2	3350
Median		4300
Average		4180

CONFIDENTIAL
SECURITY INFORMATION

APPENDIX C

CONFIDENTIAL

NPG REPORT NO. 1149

Fragmentation Test of Warhead No. 145 for Oriole Missile

TABLE VI

FRAGMENT VELOCITY DATA

30' Radius Velocity Arena 6100 Frames per sec.
16mm Fastax Camera Comp. C-3
Rd. 4, Oriole Warhead No. 145-C-1 Filler Weight 19.99 lbs.
Total Weight 35.82 lbs. Date: 16 April 1953

<u>Frame in Which Hit Occurred</u>	<u>No. Fragments</u>	<u>Velocity (f/s)</u>
35	7	5230
36	6	5080
37	7	4950
38	5	4820
39	9	4690
40	5	4580
41	7	4460
42	3	4360
43	2	4260
44	1	4160
Median		4830
Average		4770

CONFIDENTIAL
SECURITY INFORMATION

APPENDIX C

CONFIDENTIAL

NPG REPORT NO. 1149

Fragmentation Test of Warhead No. 145 for Oriole Missile

TABLE VII

FRAGMENT VELOCITY DATA

30' Radius Velocity Arena	5800 Frames per sec.
16mm Fastax Camera	Comp. C-3
Rd. 5, Oriole Warhead No. 145-C-2	Filler Weight 19.86 lbs.
Total Weight 34.45 lbs.	Date: 16 April 1953

<u>Frame in Which Hit Occurred</u>	<u>No. Fragments</u>	<u>Velocity (f/s)</u>
33	1	5270
34	13	5120
35	14	4970
36	5	4830
37	2	4700
38	8	4580
39	7	4460
40	3	4350
41	4	4240
42	2	4140
Median		4870
Average		4760

CONFIDENTIAL
SECURITY INFORMATION

APPENDIX C

Fragmentation Test of Warhead No. 145 for Oriole Missile
-----TABLE VIIIFRAGMENT VELOCITY DATA

30' Radius Velocity Arena 5800 Frames per sec.
16mm Fastax Camera Comp. C-3
Rd. 6, Oriole Warhead No. 145-C-3 Filler Weight 19.88 lbs.
Total Weight 35.73 lbs. Date: 16 April 1953

<u>Frame in Which Hit Occurred</u>	<u>No. Fragments</u>	<u>Velocity (f/s)</u>
33	3	5270
34	10	5120
35	7	4970
36	5	4830
37	6	4700
38	7	4580
39	3	4460
40	2	4350
41	3	4240
42	1	4140
43	1	4050
Median		4870
Average		4780

Fragmentation Test of Warhead No. 145 for Oriole Missile
-----TABLE IXFRAGMENT VELOCITY DATA

30' Radius Velocity Arena 6200 Frames per sec.
16mm Fastax Camera Comp. C-3
Rd. 7, Oriole Warhead No. 145-D-1 Filler Weight 24.97 lbs.
Total Weight 41.20 lbs. Date: 16 April 1953

<u>Frame in Which Hit Occurred</u>	<u>No. Fragments</u>	<u>Velocity (f/s)</u>
30	6	6200
31	25	6000
32	21	5810
33	9	5640
34	6	5470
35	4	5310
36	3	5170
37	2	5030
38	1	4890
39	3	4770
40	7	4650
41	2	4540
42	1	4430
Median		5810
Average		5610

CONFIDENTIAL

NPG REPORT NO. 1149

Fragmentation Test of Warhead No. 145 for Oriole Missile

TABLE X

FRAGMENT VELOCITY DATA

30' Radius Velocity Arena 5850 Frames per sec.
16mm Fastax Camera Comp. C-3
Rd. 8, Oriole Warhead No. 145-D-2 Filler Weight 24.99 lbs.
Total Weight 41.28 lbs. Date: 16 April 1953

<u>Frame in Which Hit Occurred</u>	<u>No. Fragments</u>	<u>Velocity (f/s)</u>
29	5	6050
30	20	5850
31	21	5660
32	9	5480
33	2	5320
34	1	5160
35	1	5010
36	3	4880
37	2	4740
38	2	4620
39	3	4500
Median		5700
Average		5550

CONFIDENTIAL
SECURITY INFORMATION

APPENDIX C

Fragmentation Test of Warhead No. 145 for Oriole Missile
-----TABLE XIFRAGMENT VELOCITY DATA

30' Radius Velocity Arena 5900 Frames per sec.
 16mm Fastax Camera Comp. C-3
 Rd. 9, Oriole Warhead No. 145-D-3 Filler Weight 25.06 lbs.
 Total Weight 41.23 lbs. Date: 17 April 1953

<u>Frame in Which Hit Occurred</u>	<u>No. Fragments</u>	<u>Velocity (f/s)</u>
29	3	6100
30	26	5900
31	23	5710
32	8	5530
33	5	5360
34	2	5210
35	3	5060
36	2	4920
37	2	4780
38	1	4660
39	1	4540
40	2	4430
Median		5760
Average		5600

Fragmentation Test of Warhead No. 146 for Oriole Missile

TABLE XII

SPACE DISTRIBUTION DATA

30' Radius Velocity Arena
1" Panels 15' high

Hit numbers recorded are estimated as
being able to penetrate 1/8" mild steel.

Polar Zone	145-A-1		145-A-2		145-A-3		Ave. No. hits on panels	No. Hits per total 5° zone
	L	R	L	R	L	R		
75°-80°	*Did		1	3	5	4	6.5	19.5
80°-85°			1	5	5	6	8.5	25.5
85°-90°	not		14	21	15	22	36	108
90°-95°			39	37	39	34	74.5	223.5
95°-100°	detonate		6	6	2	4	8.5	25.5
	145-B-1		145-B-2		145-B-3			
	L	R	L	R	L	R		
75°-80°	1	0	3	2	6	4	5.3	16
80°-85°	1	3	4	2	3	3	5.3	16
85°-90°	24	24	22	29	24	20	51	153
90°-95°	58	53	39	29	41	42	74	222
95°-100°	2	0	2	0	6	5	5	15
	145-C-1		145-C-2		145-C-3			
	L	R	L	R	L	R		
75°-80°	2	0	1	4	2	4	4.3	13
80°-85°	6	4	15	12	8	1	15.3	46
85°-90°	15	9	4	14	8	4	18	54
90°-95°	31	25	37	25	41	35	64.7	194
95°-100°	2	6	3	4	2	4	7	21
	145-D-1		145-D-2		145-D-3			
	L	R	L	R	L	R		
75°-80°	8	12	4	4	6	9	14.3	43
80°-85°	19	29	13	34	19	15	43	129
85°-90°	36	31	25	34	46	35	70	210
90°-95°	39	38	36	18	37	44	70.7	212
95°-100°	15	4	16	20	15	21	30.3	91

* The tetryl in warhead 145-A-1 ignited the Composition C-3 filler causing to burn.